

Claims:

1. A piezoelectric drive amplifier circuit comprising:
a first capacitor and a second capacitor connected in series through a transformer
comprising a first and second inductor;
5 a third inductor connected in series between the first and second capacitors; and
at least one switch for connecting the first and second capacitors and a switch controller
for controlling the at least one switch such that energy is transferred between the first and second
capacitors so that the circuit is operated at near its electrical resonance for the circuit.

2. The piezoelectric drive amplifier circuit of claim 1, wherein:

the first capacitor is a piezoelectric element and the second capacitor is a storage capacitor.

3. The piezoelectric drive amplifier circuit of claim 1, wherein:

the at least one switch includes a first switch connected in series to the first inductor, a
second switch connected in series to the second inductor, and a third switch connected in series
15 to the third inductor.

4. The piezoelectric drive amplifier circuit of claim 3, further comprising:

an error amplifier connected in parallel between the first capacitor and the second
20 capacitor.

5. The piezoelectric drive amplifier circuit of claim 4, wherein:

the error amplifier comprises an input for receiving an input signal, said error amplifier initiating a transfer of energy between the first and second capacitor in accordance with the input signal.

6. A piezoelectric drive amplifier circuit for converting electrical energy to
5 mechanical energy comprising:

a first and second capacitor capable of storing energy; and

at least one switch for connecting the first and second capacitors and a switch controller for controlling the at least one switch such that energy is transferred between the first and second capacitors so that the circuit is operated at near its electrical resonance for the circuit.

7. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 6, further comprising:

an error amplifier is connected to a switch controller and initiates the transfer of energy between the first capacitor and the second capacitor.

8. The piezoelectric drive amplifier circuit of claim 7, wherein:

the error amplifier comprises an input for receiving an input signal, said error amplifier initiating a transfer of energy between the first and second capacitor in accordance with the input signal.

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9. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 7, wherein:

the first capacitor is a piezoelectric element and the second capacitor is a storage capacitor, and the error amplifier initiates the transfer of energy from the first capacitor to the second capacitor when $(V_{cx} - V_{IN}) > \alpha\Delta V$, where V_{cx} is the voltage of the first capacitor, V_{IN} is the voltage of an input signal at the error amplifier; ΔV is a voltage step size, and α is a constant between 0 and 1.

10. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 7, wherein:

the first capacitor is a piezoelectric element and the second capacitor is a storage capacitor, and the error amplifier initiates the transfer of energy from the second capacitor to the first capacitor when $(V_{IN} - V_{cx}) > \alpha\Delta V$, where V_{cx} is the voltage of the second capacitor, V_{IN} is the voltage of an input signal at the error amplifier; ΔV is a voltage step size, and α is a constant between 0 and 1.

15 11. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 7, further comprising:

a first switch, a second switch and a third switch connected in parallel between the first and second capacitor.

20 12. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 11, wherein:

the first switch is closed to initiate the energy transfer from the first capacitor to the second capacitor.

13. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 11, wherein:

the first and second switches are closed to initiate the energy transfer from the second
5 capacitor to the first capacitor.

14. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 11, wherein:

an inductor is connected in series between the first and second capacitors.

15. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 7, wherein:

the at least one switch is a field effect transistor switch.

16. The piezoelectric drive amplifier circuit for converting electrical energy to mechanical energy of claim 7, wherein:

the at least one switch is metal oxide semiconductor field effect transistor switch.

17. A method of converting electrical energy to mechanical energy using a
20 piezoelectric drive amplifier comprising the steps of:

inputting a signal with a frequency into an error amplifier;
initiating a transfer of energy between a first and second capacitor, wherein the first
capacitor is a piezoelectric element and the second capacitor is a storage capacitor; and

converting the energy in the first capacitor into mechanical energy.

18. The method of converting electrical energy to mechanical energy using a piezoelectric drive amplifier of claim 17, further comprising the steps of:

5 initiating the transfer of energy from the first capacitor to the second capacitor when $(V_{cx} - V_{IN}) > \alpha\Delta V$, where V_{cx} is the voltage of the second capacitor, V_{IN} is the voltage of an input signal at the error amplifier; ΔV is a voltage step size, and α is a constant between 0 and 1.

10 19. The method of converting electrical energy to mechanical energy using a piezoelectric drive amplifier of claim 17, further comprising the steps of:

initiating the transfer of energy from the second capacitor to the first capacitor when $(V_{IN} - V_{cx}) > \alpha\Delta V$, where V_{cx} is the voltage of the second capacitor, V_{IN} is the voltage of an input signal at the error amplifier; ΔV is a voltage step size, and α is a constant between 0 and 1.

15 20. The method of converting electrical energy to mechanical energy using a piezoelectric drive amplifier of claim 17, further comprising the steps of:

adding energy to the second capacitor to compensate for energy lost due to mechanical work in the piezoelectric element.